U.S. Department of the Interior
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Prepared in cooperation with the
U.S. Army Corps of Engineers, Albuquerque District, and the U.S. Fish and Wildlife Service

Scientific Investigations Map 3350
Sheet 1 of 7

Introduction

From its headwaters in Colorado to its terminus at the Gulf of Mexico (fig. 1), the Rio Grande provides vital habitat to a variety of species adapted to its natural flood regime (Schmidt and others, 2003). The Rio Grande is the second longest river in North America. The principal natural flood regime from the headwaters downstream to Presidio, Texas, is the result of snowmelt runoff between April and July in Colorado and New Mexico; downstream from Presidio, the natural flood regime is the result of summer thunderstorms (U.S. Army Corps of Engineers and others, 2007; Schmidt and others, 2003). Native species in the Rio Grande, including *Hybognathus amarus* (Rio Grande silvery minnow) (fig. 2) and other small-bodied fish, are adapted to the natural flood regime of the Rio Grande (Sublette and others, 1990; Crawford and others, 1993). Background on this species and associated issues as well as a complete description of the study area can be found in the companion report to this one (Braun and others, 2015).

Federally listed as an endangered species in 1994 (U.S. Fish and Wildlife Service, 1994), the Rio Grande silvery minnow historically occupied about 4,000 kilometers (km) in the main stems of the Rio Grande and the Pecos River (fig. 1) (U.S. Fish and Wildlife Service, 2010). The decline of the Rio Grande silvery minnow throughout its historical range has been attributed to modifications of the natural streamflow regime, channel drying, construction of reservoirs and low-head diversion dams, stream channelization, declining water quality, and interactions with nonnative fish (Cook and others, 1992; Edwards, 2005; U.S. Fish and Wildlife Service, 2010). Natural populations of the Rio Grande silvery minnow currently (2015) are found only in the reach of the Rio Grande in N. Mex. that extends about 280 km between Cochiti Dam and Elephant Butte Reservoir (fig. 1) (U.S. Fish and Wildlife Service 2010; Gonzales and others, 2014), referred to as the "Middle Rio Grande" for the purpose of this report.

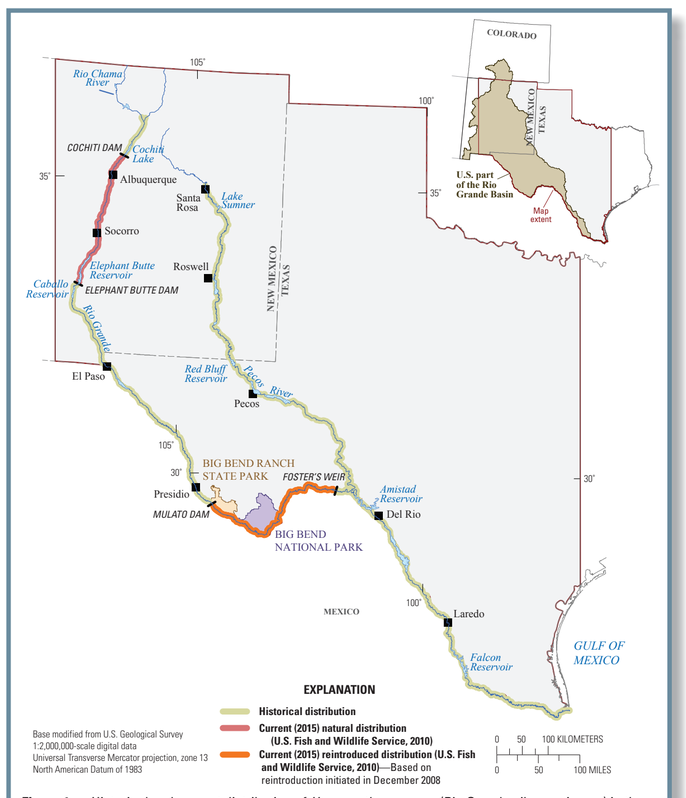

Figure 1. Historical and current distribution of *Hypognathus amarus* (Rio Grande silvery minnow) in the Rio Grande and Pecos River, New Mexico and Texas.

Figure 2. Nursery raised *Hybognathus amarus* (Rio Grande silvery minnow) with tagged dorsal fin; colored dorsal fin tag was attached for identification purposes and corresponds to the reach of the Middle Rio Grande in which it was released.

A mesohabitat scale assessment of available in-channel habitat in relation to streamflows is considered by many ecologists and fluvial geomorphologists to be critical for the development of practical tools in river management (Harper and Everard, 1998; Newson and Newson, 2000), and the availability of functional habitat is essential for maintaining viable fish populations (Lapointe and others, 2013). Mesohabitats are visually distinct units of habitat within a stream with apparent uniformity (Pardo and Armitage, 1997; Parasiewicz, 2001) and with similar depth, velocity, slope, substrate, and cover. Mesohabitat-scale assessments provide information on habitat area as a function of alterations in river flow, channel planform, and other activities (Parasiewicz, 2001).

Mesohabitat use by Rio Grande silvery minnows, along with the physical properties of depth, velocity, and substrate, have been the subject of previous studies (Dudley and Platania, 1997; Dudley and others, 2012, 2013; Moring and others, 2014); however, information on the spatial extent of available mesohabitats over a range of streamflows throughout the Middle Rio Grande remains sparse (Remshardt and Tashjian, 2003). To better understand the spatial extent of available mesohabitats over a range of streamflows, the U.S. Geological Survey (USGS), in cooperation with the U.S. Army Corps of Engineers, Albuquerque District, and the U.S. Fish and Wildlife Service New Mexico Fish and Wildlife Conservation Office in Albuquerque, N. Mex., evaluated physical characteristics and mapped mesohabitats associated with small-bodied fish assemblages during 2011–12 during moderate and low streamflow at 15 sites on the Middle Rio Grande in New Mexico, in the reach between Cochiti Dam and Elephant Butte Reservoir.

Purpose and Scope

This report documents differences in the mapped spatial extents and physical characteristics of in-channel fish habitat evaluated at the mesohabitat scale during winter 2011–12 (moderate streamflow) and summer 2012 (low streamflow) at 15 sites on the Middle Rio Grande in New Mexico starting about 3 km downstream from Cochiti Dam and ending about 40 km upstream from Elephant Butte Reservoir (fig. 3). The results of mesohabitat mapping, physical characterization, and fish assemblage surveys are summarized from the data that were collected. The report also presents general comparisons of physical mesohabitat data, such as wetted area and substrate type, and biological mesohabitat data, which included fish assemblage composition, species richness, Rio Grande silvery minnow relative abundance, and Rio Grande silvery minnow catch per unit effort. Selected water-quality properties (water temperature, specific conductance, dissolved oxygen, and pH) that were collected during low-flow conditions were published and analyzed in Braun and others (2015) and are not discussed in this report.

Description of Study Area

Braun and others (2015) provided a detailed description of the Middle Rio Grande; a brief description is provided herein. The Middle Rio Grande is an arid part of the Rio Grande Basin dependent on inflows from upstream. Historically, discharge in the Middle Rio Grande fluctuated between seasonal peaks from snowmelt runoff and from localized thunderstorms in the spring and early summer (U.S. Army Corps of Engineers and others, 2007) to periods of river fragmentation during late summer when some river segments would go dry (Tetra Tech, Inc., 2014). Today, the Middle Rio Grande is a highly regulated system influenced by numerous storage and flood control reservoirs, low-head diversion dams, and almost 1,500 km of irrigation canals and drainages between Cochiti Dam and Elephant Butte Reservoir. Dams, diversions, and canals have not altered the preregulation seasonal streamflow pattern (fig. 4) but have dampened the magnitude and duration of extreme streamflow events and have led to extended periods when the river is dry downstream from Albuquerque during the summer to the early fall irrigation period (U.S. Bureau of Reclamation, 2012).

The channel planform of the Middle Rio Grande has changed during the last 100 years from a braided aggrading channel to one that is mostly degrading, transitioning from a braided, sand-bed channel to a narrower, single-threaded channel that is dominated by a gravel bed through much of its length (Makar and AuBuchon, 2012). Between 1935 and 1989, the river channel area of the Middle Rio Grande decreased by about 50 percent (Crawford and others, 1993). Channel narrowing can be attributed to reductions in sediment supply, changes in peak spring flows caused by upstream flood control, channelization activities, and other river training actions used to manage flows for irrigation purposes (Makar and Aubuchon, 2012). The effects of changes in the Rio Grande planform on native fish species were summarized by Schmidt and others (2003, p. 25–26):

> Historically, the Rio Grande had a mobile bed and erodible banks, and the channel changed from year to year. Today's channel is smaller, more stable, changes less from year to year, and infrequently inundates its former floodplain.*** The Rio Grande silvery minnow is adapted to the former wide shallow braided channel and associated habitats, and its population has declined greatly in response to channelization and diminished flows.

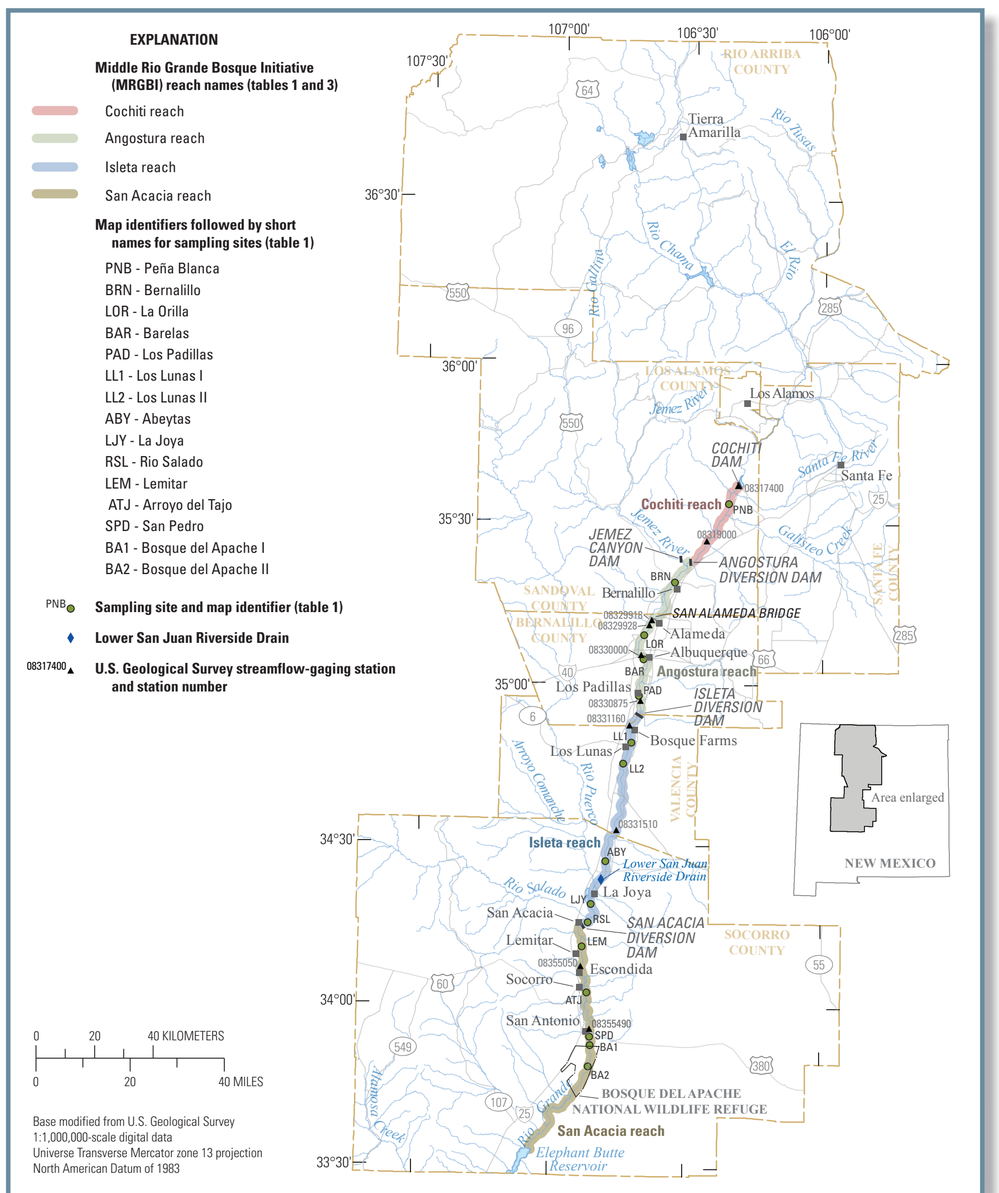

Figure 3. Sites where mesohabitats were assessed and Middle Rio Grande Bosque Initiative reaches on the Middle Rio Grande in New Mexico, 2011–12.

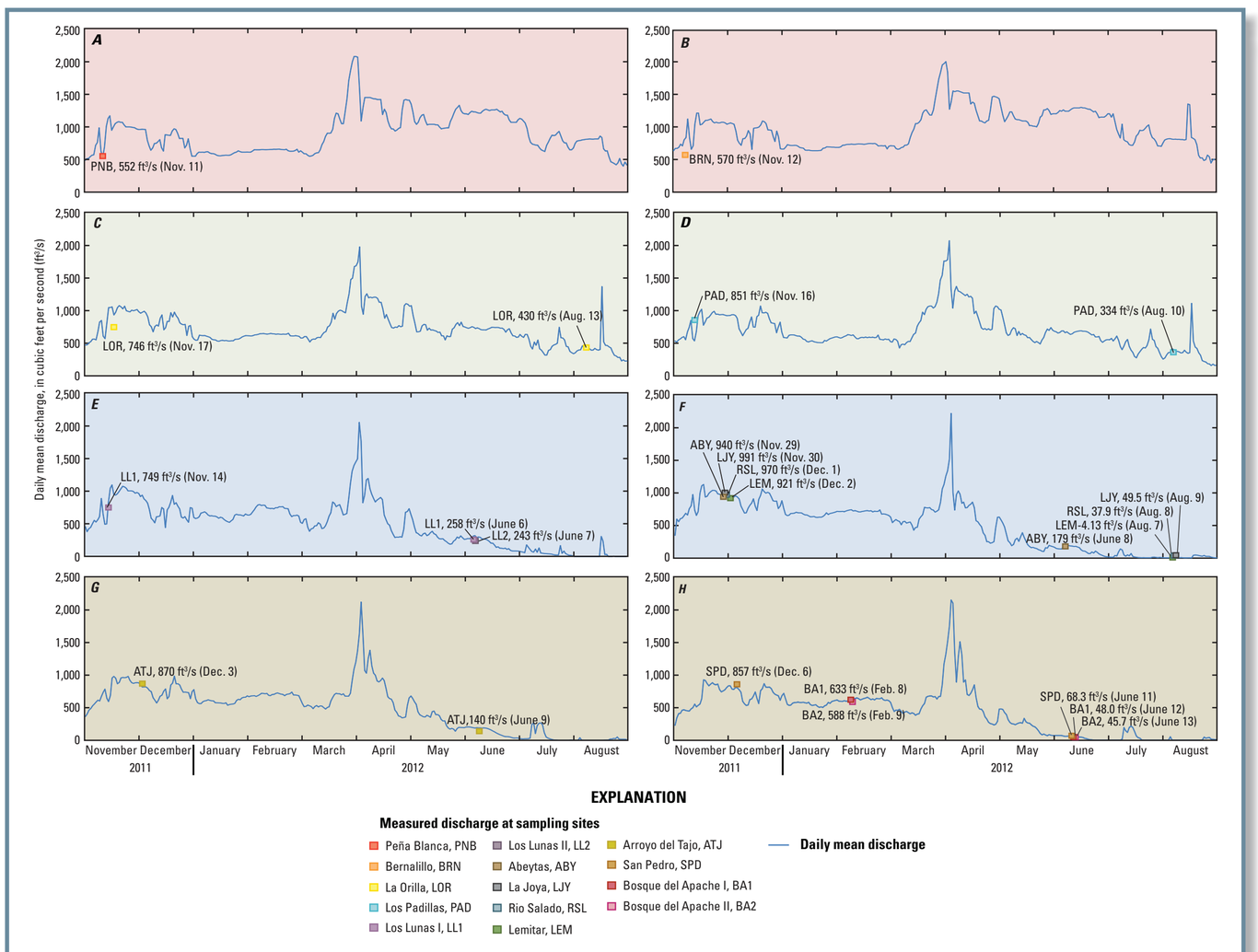

Figure 4. Measured discharge at sampling sites and daily mean discharge at U.S. Geological Survey streamflow-gaging stations on the Middle Rio Grande, New Mexico. *A*, 08317400 Rio Grande below Cochiti Dam, N. Mex.; *B*, 08319000 Rio Grande at San Felipe, N. Mex.; *C*, 08329928 Rio Grande at Alameda, N. Mex.; *D*, 08330000 Rio Grande at Albuquerque, N. Mex.; *E*, 08331160 Rio Grande near Bosque farms, N. Mex.; *F*, 08331510 Rio Grande at State Highway 346 near Bosque, N. Mex.; *G*, 08355050 Rio Grande at bridge near Escondida, N. Mex.; and *H*, 08355490 Rio Grande above U.S. Highway 380 near San Antonio, N. Mex.; November 1, 2011–August 31, 2012.

Methods of Investigation

The physical characteristics and fish assemblage of stream mesohabitats were characterized within a 1-km length of stream channel at 15 sites distributed along the Middle Rio Grande and were selected starting about 3 km downstream from Cochiti Dam and ending about 40 km upstream from Elephant Butte Reservoir (table 1, fig. 3). Sites along the Middle Rio Grande were grouped into four river reaches separated by diversion dams. In downstream order, the names of the diversion dams followed by short names of the sites (in parentheses) were Cochiti (Peña Blanca), Angostura (Bernalillo, La Orilla, Barelas, Los Padillas), Isleta (Los Lunas I, Los Lunas II, Abeytas, La Joya, Rio Salado), and San Acacia (Lemitar, Arroyo del Tajo, San Pedro, Bosque del Apache I, and Bosque del Apache II). The Cochiti, Angostura, and Isleta reaches are bound by upstream and downstream diversion dams (fig. 3), whereas there is a diversion dam at the upstream boundary of the San Acacia reach, but the downstream boundary of the reach is the upstream extent of Elephant Butte Reservoir. Stream habitat was mapped in the field by using a geographic information system (GIS) in conjunction with a Global Positioning System (GPS). The four reaches delineated in this report are also being assessed as part of the Middle Rio Grande Bosque Initiative (MRGBI). The MRGBI "is an ongoing, congressionally supported, interagency ecosystem management effort to coordinate activities related to the ecological restoration and management of the Middle Rio Grande" (U.S. Fish and Wildlife Service, 2014, p. 1).

Table 1. Study sites and sampling dates in the Middle Rio Grande, New Mexico, 2010–11 (reach names are from U.S. Fish and Wildlife Service, 2014).

[MRGBI, Middle Rio Grande Bosque Initiative; nr, near; dws, downstream from; ups, upstream from; --, no data were collected during this time period]

U.S. Geological Survey site name	U.S. Geological Survey site number	Short name	Map identifier	MRGBI reach names[1]	Dates sampled: November–December 2011 Mapping	November–December 2011 Fish and aquatic habitat	February 2012 Mapping	February 2012 Fish and aquatic habitat	July–August 2012 Mapping	July–August 2012 Fish and aquatic habitat
Rio Grande nr Pena Blanca, N. Mex.	353330106213500	Peña Blanca	PNB	Cochiti	Nov. 10	Nov. 11	--	--	--	--
Rio Grande dws Hwy 550 at Bernalillo, N. Mex.	351848106333400	Bernalillo	BRN	Angostura	Nov. 11	Nov. 12	--	--	--	--
Rio Grande ups Montano Rd NW at Albuquerque, N. Mex.	350859106402600	La Orilla	LOR	Angostura	Nov. 16	Nov. 17	--	--	Aug. 11	Aug. 13
Rio Grande ups Hwy 314 at Albuquerque, N. Mex.	350432106400500	Barelas	BAR	Angostura	Nov. 9	Nov. 10	--	--	Aug. 10	Aug. 11
Rio Grande ups I-25 nr Los Padillas, N. Mex.	345732106410800	Los Padillas	PAD	Angostura	Nov. 15	Nov. 16	--	--	Aug. 9	Aug. 10
Rio Grande ups Hwy 6 at Los Lunas, N. Mex.	344852106424200	Los Lunas I	LL1	Isleta	Nov. 12	Nov. 14	--	--	June 5	June 6
Rio Grande nr Los Chavez, N. Mex.	344457106443300	Los Lunas II	LL2	Isleta	Nov. 14	Nov. 15	--	--	June 6	June 7
Rio Grande ups Hwy 60 nr Contreras, N. Mex.	342644106481300	Abeytas	ABY	Isleta	Nov. 28	Nov. 29	--	--	June 7	June 8
Rio Grande nr La Joya, N. Mex.	341842106511100	La Joya	LJY	Isleta	Nov. 29	Nov. 30	--	--	Aug. 8	Aug. 9
Rio Grande dws Arroyo Rosa de Castillo, San Acacia	341542106520700	Rio Salado	RSL	Isleta	Nov. 30	Dec. 1	--	--	Aug. 7	Aug. 8
Rio Grande nr Lemitar, N. Mex.	341044106530300	Lemitar	LEM	San Acacia	Dec. 1	Dec. 2	--	--	Aug. 6	Aug. 7
Rio Grande dws Arroyo del Tajo nr Socorro, N. Mex.	340215106515500	Arroyo del Tajo	ATJ	San Acacia	Dec. 1	Dec. 3	--	--	June 8	June 9
Rio Grande dws Hwy 380 nr San Antonio, N. Mex.	335403106505800	San Pedro	SPD	San Acacia	[2]Dec. 3	[2]Dec. 6	[2]Feb. 6	[2]Feb. 7	June 9	June 11
Rio Grande N of Bosque del Apache, San Antonio, N. Mex.	335229106505800	Bosque del Apache I	BA1	San Acacia	--	--	[2]Feb. 7	[2]Feb. 8	June 11	June 12
Rio Grande at Bosque del Apache nr San Antonio, N. Mex.	334833106512200	Bosque del Apache II	BA2	San Acacia	[2]Dec. 6	--	[2]Feb. 8	[2]Feb. 9	June 12	June 13

[1] MRGBI reach names are from U.S. Fish and Wildlife Service (2014); colors associated with reaches are used throughout the report.
[2] Inclement weather made accurate mapping and representative fish sampling impossible. As a result, the San Pedro, Bosque del Apache I, and Bosque del Apache II sites were revisited in February 2012, when weather conditions were more suitable.

For sale by U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225, 1–888–ASK–USGS

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Fish Assemblage Composition and Mapped Mesohabitat Features Over a Range of Streamflows in the Middle Rio Grande, New Mexico, Winter 2011–12, Summer 2012

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